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FOR: HERMETIC COMPRESSOR

VERIFICATION OF A TRANSLATION

Assistant Commissioner for Patents
Washington, D.C. 20231
SIR :

I, the below named translator, hereby declare that:

1. My name and post office address are as stated below.

2. That I am knowledgeable in the English language and in the language of JP2004-338443, and I believe the attached English translation to be a true and complete translation of JP2004-338443.

3. The document for which the attached English translation is being submitted is a patent application on an invention entitled HERMETIC COMPRESSOR.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: August 17, 2009

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[NAME OF ARTICLE] Specification 1
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[NAME OF ARTICLE] Abstract 1

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[Name of the Document] Claims

[Claim 1]

A hermetic compressor comprising a hermetic container for reserving a lubricating oil, and accommodating a motor element and a compressing element driven by the motor element, wherein the compressing element comprises a shaft having an eccentric shaft and a main shaft, a main bearing for pivoting the main shaft, and the motor element is a bipolar permanent magnet type motor having a stator and a rotor with a permanent magnet built in a rotor core, a hollow bore is formed in an end portion at the compressing element side of the rotor core, and the main bearing extends internally of the bore, and stack thickness that is the axial length of the rotor core is longer than the stack thickness of the stator core of the stator.

[Claim 2]

The hermetic compressor of claim 1, wherein both ends in an axial direction of the rotor core are respectively positioned outside both ends in an axial direction of the stator core.

[Claim 3]

The hermetic compressor of claim 1, wherein the axial length of the permanent magnet is shorter than the axial length of the rotor core.

[Claim 4]

The hermetic compressor of claim 1, wherein the axial length of the permanent magnet is shorter than the axial length of the rotor core, and the permanent magnet is positioned at the opposite side of the bore side of the rotor.

[Claim 5]

The hermetic compressor of any one of claims 1 to 4, wherein the bipolar permanent magnet type motor is a self-start type permanent magnet synchronous motor comprising many conductor bars, starting cage conductors, at an outer periphery of the rotor core, and a rotor with a plurality of permanent magnets buried at the inside thereof.

[Claim 6]

The hermetic compressor of any one of claims 1 to 5, wherein the permanent magnet is a rare earth magnet.

[Name of the document] Specification

[Title of the Invention] Hermetic compressor

[Field of the Invention]

[0001]

The present invention relates to a hermetic compressor used for a refrigeration cycle of a refrigerator freezer and the like.

[Background Art]

[0002]

Recently, as for a hermetic compressor used in a freezing device of a refrigerator freezer and the like, efficiency increase is desired for reducing the power consumption, and size reduction is desired for increasing the volume efficiency of the refrigerator freezer.

[0003]

Available as a conventional hermetic compressor of this type is a bipolar permanent magnet type motor having a built-in permanent magnet in a rotor as a motor element instead of an induction motor for the purpose of efficiency improvement (e.g. refer to Patent document 1).

[0004]

The conventional hermetic compressor will be described in the following with reference to the drawings.

[0005]

Fig. 5 is a longitudinal sectional view of the conventional hermetic compressor mentioned in Patent document 1. As shown in Fig. 5, hermetic container 1 accommodates motor element 4 formed of stator 2 and rotor 3, and compressing element 5 driven by motor element 4. Lubricating oil 6 is

reserved in hermetic container 1. Shaft 10 has main shaft 11 on which rotor 3 is fixed and eccentric shaft 12 eccentrically formed with respect to main shaft 11. Cylinder block 14 has nearly cylindrical compression chamber 15, on which main bearing 17 formed from an aluminum-based non-magnetic material is fixed. Piston 19 is inserted into compression chamber 15 of cylinder block 14 in a reciprocally free-to-slide fashion, and its connection to eccentric shaft 12 is made by connecting means 20.

[0006]

Motor element 4 is a bipolar permanent magnet type motor comprising stator 2 with winding wound on stator core 25 formed by laminated magnetic steel sheet, and rotor 3 with permanent magnet 27 built in rotor core 26 formed by laminated magnetic steel sheet. Also, end plate 28 for protection is fixed on rotor core 26 in order to prevent falling off of permanent magnet 27.

[0007]

Also, hollow bore 31 is disposed at the end portion opposite to compressing element 5 of rotor core 26, and main bearing 17 extends internally of hollow bore 31.

[0008]

The operation of a hermetic compressor having the above configuration will be described in the following.

[0009]

Rotor 3 of motor element 4 rotates shaft 10, and as the rotating motion of eccentric shaft 12 is transmitted to piston 19 via connecting means 20, piston 19 reciprocally moves in compression chamber 15. In this

way, the refrigerant gas is taken from a cooling system (not shown) into compression chamber 15 and compressed therein, and after that, it is discharged again into the cooling system.

[0010]

The flow and loss of magnetic flux in rotation of rotor 3 is described in the following. Because main bearing 17 is formed from a non-magnetic material, no magnetic attraction is produced between the inner periphery of bore 31 and main bearing 17, generating no loss of torque. Also, the magnetic flux from permanent magnet 27 is not attracted to main bearing 17 because main bearing 17 is non-magnetic, and most of it passes only in rotor core 26. Accordingly, almost no iron loss (eddy-current loss in particular) is generated in main bearing 17, thereby improving the high efficiency.

[Patent document 1] Unexamined Japanese Patent Publication 2001-73948.

[Disclosure of the Invention]

[Problems to be Solved by the Invention]

[0011]

However, in the above-mentioned conventional configuration, the stator core is relatively small in section area at the outer periphery of the bore, only forming a partially narrow magnetic path and increasing in magnetic resistance, and as a result, the amount of magnetic flux near the bore becomes less as compared with the case of no bore, and there arises a problem of increase of the loss.

[0012]

Also, in case the bore is eliminated from the structure in order to reduce the loss at the bore, the main bearing is unable to extend into such a bore, and the rotor moves to the opposite side of the compressing element for the depth of the bore, and there is a problem that the hermetic container becomes increased in height for the depth of the bore as a result.

[0013]

The present invention is intended to solve such a conventional problem, and the object is to provide a high efficiency hermetic compressor reduced in size, weight and cost, which may improve the efficiency by increasing the amount of magnetic flux generated by the permanent magnet without increasing the height of the hermetic container.

[Means to Solve the Problems]

[0014]

In order to solve the above conventional problem, the hermetic compressor of the present invention is a bipolar permanent magnet type motor whose motor element comprises a stator and a rotor with a permanent magnet built in a rotor core, and a hollow bore is formed in the end portion at the compressing element side of the rotor core, and a main bearing extends internally of the bore, and stack thickness that is the axial length of the rotor core is longer than the stack thickness of the stator core of the stator. Accordingly, it brings about an effect of improving the efficiency of the motor element, increasing the amount of conventionally insufficient magnetic flux generated in the rotor core.

[Advantages of the Invention]

[0015]

The hermetic compressor of the present invention is small-sized and light-weight because the stack thickness of the rotor core is increased in length, which gives no direct influence to the height of the hermetic container, and the loss is reduced by increasing the amount of magnetic flux in the rotor core, and thereby, it is possible to improve the efficiency.

[Description of the Preferred Embodiments]

[0016]

The invention of claim 1 is a hermetic compressor comprising a hermetic container for reserving a lubricating oil, and accommodating a motor element and a compressing element driven by the motor element, wherein the compressing element comprises a shaft having an eccentric shaft and a main shaft, a main bearing for pivoting the main shaft, and the motor element is a bipolar permanent magnet type motor having a stator and a rotor with a permanent magnet built in a rotor core, a hollow bore is formed in an end portion at the compressing element side of the rotor core, and the main bearing extends internally of the bore, and stack thickness that is the axial length of the rotor core is longer than the stack thickness of the stator core of the stator. Accordingly, the magnetic path of the rotor core can be formed wider, and it is possible to increase the amount of magnetic flux in the rotor core, that is conventionally insufficient because of the magnetic path narrowed by the bore, and to reduce the loss. Also, the stack thickness of the rotor core giving no direct influence to the height of the hermetic container is increased in length, and therefore, the hermetic container is not increased in height. In this way, it is possible to reduce the size, weight and cost, and to improve the efficiency.

[0017]

The invention of claim 2 is the hermetic compressor of claim 1, wherein both ends in the axial direction of the rotor core are respectively positioned outside the both ends in the axial direction of the stator core. Accordingly, the stator and the rotor are nearly aligned to each other with respect to their magnetic centers, and therefore, almost no magnetic force is generated in the axial direction, and the magnetic force acting on the rotor can be effectively changed to torque for rotating the shaft. As a result, it is possible to further improve the efficiency in addition to the advantage of the invention of claim 1.

[0018]

The invention of claim 3 is the hermetic compressor of claim 1, wherein the axial length of the permanent magnet is shorter than the axial length of the rotor core. Accordingly, the magnetic flux generated by the permanent magnet is hard to leak outside from the axial end of the rotor core, enabling the reduction of the material cost of the permanent magnet without so much decreasing the amount of effective flux. As a result, it is possible to further reduce the cost in addition to the advantage of the invention of claim 1.

[0019]

The invention of claim 4 is the hermetic compressor of claim 1, wherein the axial length of the permanent magnet is shorter than the axial length of the rotor core, and the permanent magnet is positioned at the opposite side of the bore of the rotor. Accordingly, the magnetic flux is generated by the permanent magnet mainly at a broad portion having no

bore of the rotor core, and therefore, a wide magnetic path can be formed and the material cost of the permanent magnet can be reduced without lessening the amount of effective magnetic flux of the permanent magnet. As a result, it is possible to further reduce the cost in addition to the advantage of the invention of claim 1.

[0020]

The invention of claim 5 is the hermetic compressor of any one of claims 1 to 4, wherein the bipolar permanent magnet type motor is a self-start type permanent magnet synchronous motor comprising many conductor bars, starting cage conductors, at an outer periphery of the rotor core, and a rotor with a plurality of permanent magnets buried therein. Accordingly, a synchronous motor capable of obtaining high efficiency due to the effect of the invention of claims 1 to 4 can be employed, and it is possible to improve the efficiency.

[0021]

The invention of claim 6 is the hermetic compressor of any one of claims 1 to 5, wherein the permanent magnet is a rare earth magnet. Accordingly, a strong magnetic force can be obtained by the rare earth magnet, and it is possible to make the motor and the hermetic compressor reduced in size and weight.

[0022]

The preferred embodiments of the present invention will be described in the following with reference to the drawings. This invention is not limited by the preferred embodiments.

[0023]

(Preferred Embodiment 1)

Fig. 1 is a longitudinal sectional view of a hermetic compressor in the preferred embodiment 1 of the present invention. Fig. 2 is an axial sectional view of a portion having no bore in the rotor of the preferred embodiment. Fig. 3 is an axial sectional view of a portion having bore in the rotor of the preferred embodiment.

[0024]

In Fig. 1, Fig. 2, Fig. 3, lubricating oil 102 is reserved in hermetic container 101, and also, it accommodates motor element 103 and compressing element 105 driven by motor element 103, and compressing element 105 comprises shaft 110 having eccentric shaft 106 and main shaft 107, and main bearing 111 for pivoting main shaft 107. Cylinder block 112 has generally cylindrical compression chamber 113, and main bearing 111 formed from an aluminum material that is a non-magnetic material is fixed thereon. Piston 114 is inserted into compression chamber 113 of cylinder block 112 in a reciprocally free-to-slide fashion, and its connection to eccentric shaft 106 is made by connecting means 115.

[0025]

Motor element 103 is a bipolar self-start type permanent magnet synchronous motor comprising stator 121 and rotor 125 with permanent magnet 124 built in rotor core 123, stack thickness that is the axial length of rotor core 123 is longer than the stack thickness of stator core 126 of stator 121. Also, end plate 127 for protection is fixed on rotor core 123 in order to prevent falling off of permanent magnet 124. Many conductor bars 128 disposed at rotor core 123 are integrated by aluminum die casting with

shorting ring 129 positioned at both ends in the axial direction of rotor core 123, thereby forming a starting cage conductor.

[0026]

Both ends in the axial direction of rotor core 123 are positioned respectively outside the both ends in the axial direction of stator core 126. Hollow bore 131 is disposed at the end of compressing element 105 of rotor core 123, and main bearing 111 extends internally of bore 131.

[0027]

Permanent magnet 124 is formed from a strong magnetic material of neodymium, iron, or boron type, which is a plate-like rare earth magnet. As shown in Fig. 2, permanent magnets being same in polarity are inserted so as to confront with each other in an angular fashion and thus buried in the axial direction of rotor core 123. A single-polar rotor magnetic pole is formed by two pieces of permanent magnets 124, and a bipolar rotor magnetic pole is formed by the whole of rotor 125. Also, barrier 132 for magnet shorting prevention is formed in order to prevent magnetic flux shorting between adjacent permanent magnets 124, and the hole of barrier 132 is filled with aluminum die cast.

[0028]

Refrigerant used for this compressor is a hydrocarbon refrigerant or the like that is a natural refrigerant being low in warming coefficient especially such as R134a and R600a whose ozone destruction coefficient is zero, which is combined with a lubricating oil having high compatibility.

[0029]

The operation and effect of the hermetic compressor having such a

configuration will be described in the following.

[0030]

Rotor 125 of motor element 103 rotates shaft 110, and the rotation of eccentric shaft 106 is transmitted to piston 114 via connecting means 115, causing piston 114 to reciprocate in compression chamber 113. In this way, the refrigerant gas is taken into compression chamber 113 from a cooling system (not shown) and compressed therein, and after that, it is again discharged into the cooling system.

[0031]

Next, the flow of magnetic flux of permanent magnet 124 is conceptually described by using the arrow-mark lines in Fig. 2 and Fig. 3. As to the flow of magnetic flux at a portion having no bore 131 in rotor core 123, as shown in Fig. 2, the magnetic flux coming out of two permanent magnets 124, shown at top of the figure, passes the center of rotor core 123, and is attracted to two permanent magnets 124, shown at bottom of the figure. On the other hand, as to the flow of magnetic flux at a portion having bore 131 in rotor core 123, as shown in Fig. 3, the magnetic flux coming out of two permanent magnets 124, shown at top of the figure, does not pass in hollow bore 131 but goes a way around to the vicinity of outer periphery of bore 131, causing the magnetic path there to become rather narrow and insufficient.

[0032]

However, stack thickness that is the axial length of rotor core 123 is longer than the stack thickness of stator core 126 of stator 121, and therefore, the magnetic path can be widely formed in the axial direction of

rotor core 123, and as a result, the amount of conventionally insufficient magnetic flux in rotor core 123 is increased and the loss is reduced. Also, the stack thickness of rotor core 123 that gives no direct influence to the height of hermetic container 101 is increased in length, and therefore, hermetic container 101 does not increase in height. Further, as compared with the case of no bore 131, hermetic container 101 becomes decreased in height for the depth of bore 131, and it is possible to reduce the size and weight.

[0033]

Also, since it is configured in that both ends in the axial direction of rotor core 123 are positioned respectively outside both ends in the axial direction of stator core 126, the magnetic centers of stator 121 and rotor 125 are nearly aligned with each other, and therefore, almost no magnetic force is axially generated and the magnetic force acting on rotor 125 can be effectively changed to torque for rotating shaft 110, thereby further improving the efficiency.

[0034]

Accordingly, it is possible to reduce the size, weight and cost, and also to improve the efficiency.

[0035]

When a hollow portion exists in the shaft for the purpose of lubrication or the like, the magnetic path is liable to become insufficient the same as in the case of having bore 131, and therefore, the configuration described above displays further effective function, making it possible to obtain same effect.

[0036]

(Preferred Embodiment 2)

Fig. 4 is a longitudinal sectional view of a hermetic compressor in the preferred embodiment 2 of the present invention. Same components as in the preferred embodiment 1 are given same reference numerals and the detailed description is omitted.

[0037]

In Fig. 4, lubricating oil 102 is reserved in hermetic container 101, and also, it accommodates motor element 201 and compressing element 105 driven by motor element 201, and compressing element 105 comprises shaft 110 having eccentric shaft 106 and main shaft 107, and main bearing 111 for pivoting main shaft 107. Cylinder block 112 has generally cylindrical compression chamber 113, and main bearing 111 formed from an aluminum material that is a non-magnetic material is fixed thereon. Piston 114 is inserted into compression chamber 113 of cylinder block 112 in a reciprocally free-to-slide fashion, and its connection to eccentric shaft 106 is made by connecting means 115.

[0038]

Motor element 201 is a bipolar self-start type permanent magnet synchronous motor comprising stator 202 and rotor 206 with permanent magnet 205 built in rotor core 203, stack thickness that is the axial length of rotor core 203 is longer than the stack thickness of stator core 210 of stator 202. Also, end plate 211 for protection is fixed on rotor core 203 in order to prevent falling off of permanent magnet 205.

[0039]

Hollow bore 212 is disposed at the end of compressing element 105 of rotor core 203, and main bearing 111 extends internally of bore 212. The axial length of permanent magnet 205 is shorter than the axial length of rotor core 203, and permanent magnet 205 is positioned at the opposite side of bore 212 of rotor 206.

[0040]

Permanent magnet 205 is formed from a strong magnetic material of neodymium, iron, or boron type, which is a plate-like rare earth magnet. Same as in Fig. 2 and Fig. 3, permanent magnets being same in polarity are inserted so as to confront with each other in an angular fashion and thus buried in the axial direction of rotor core 203. A single-polar rotor magnetic pole is formed by two pieces of permanent magnets 205, and a bipolar rotor magnetic pole is formed by the whole of rotor 206. Many conductor bars disposed at rotor core 203 are integrated by aluminum die casting with shorting ring 213 positioned at both ends in the axial direction of rotor core 203, thereby forming a starting cage conductor. Also, barrier 132 for magnet shorting prevention is formed in order to prevent magnetic flux shorting between adjacent permanent magnets 205, and the hole of barrier 132 is filled with aluminum die cast.

[0041]

Refrigerant used for this compressor is a hydrocarbon refrigerant or the like that is a natural refrigerant being low in warming coefficient especially such as R134a and R600a whose ozone destruction coefficient is zero, which is combined with a lubricating oil having compatibility.

[0042]

The operation of the hermetic compressor having such a configuration will be described in the following.

[0043]

Rotor 206 of motor element 103 rotates shaft 110, and the rotation of eccentric shaft 106 is transmitted to piston 114 via connecting means 115, causing piston 114 to reciprocate in compression chamber 113. In this way, the refrigerant gas is taken into compression chamber 113 from a cooling system (not shown), and after being compressed, it is again discharged to the cooling system.

[0044]

Next, the flow of magnetic flux of permanent magnet 205 is conceptually described. As to the flow of magnetic flux at a portion having no bore 212 in rotor 206, same as in Fig. 2, the magnetic flux coming out of permanent magnet 205 passes the center of rotor core 203. On the other hand, as to the flow of magnetic flux at a portion having bore 212 in rotor 206, same as in Fig. 3, the magnetic flux coming out of permanent magnet 205 does not pass in hollow bore 212 but goes a way around to the vicinity of bore 131, causing the magnetic path there to become rather narrow and insufficient.

[0045]

However, since it is configured in that the axial length of permanent magnet 205 is shorter than the axial length of rotor core 203, the magnetic flux generated by permanent magnet 205 is hard to leak outside from the axial end of rotor core 203, enabling the reduction of the material cost of the permanent magnet 205 without so much decreasing the amount of effective

flux.

[0046]

Further, since it is configured in that permanent magnet 205 is positioned at the opposite side of bore 212 of rotor 206, the magnetic flux by permanent magnet 205 is mainly generated at a portion having no bore 212 of rotor core 203, and therefore, a wide magnetic path can be formed with respect to the size of permanent magnet 205, and it is possible to reduce the material cost of permanent magnet 205 without so much decreasing the amount of effective flux of permanent magnet 205. Accordingly, requirements for both of high efficiency and low cost can be achieved.

[0047]

Also, permanent magnet 205 is formed by using rare earth magnet, and strong magnetic forces can be obtained by the rare earth magnet, and it is possible to make the motor and the hermetic compressor reduced in size, weight and cost.

[0048]

Accordingly, it is possible to further reduce the size, weight and cost, and also to improve the efficiency.

[0049]

When a hollow portion in the lubrication passage or the like exists in main shaft 107 of shaft 110, the magnetic path is liable to become insufficient the same as in the case of having bore 212, and therefore, the configuration described above displays further effective function, making it possible to obtain same effect.

[Industrial Applicability]

[0050]

As described above, the hermetic compressor of the present invention is capable of decreasing the loss by increasing the amount of magnetic flux of the rotor core, reducing the size and weight, and improving the efficiency. Accordingly, it is possible to make developments toward the use for air conditioners and hermetic compressors of refrigerator freezers.

[Brief Description of the Drawings]

[0051]

Fig. 1 is a longitudinal sectional view of a hermetic compressor in the preferred embodiment 1 of the present invention.

Fig. 2 is an axial sectional view of a portion having no bore in rotor in the preferred embodiment.

Fig. 3 is an axial sectional view of a portion having bore in rotor in the preferred embodiment.

Fig. 3 is a longitudinal sectional view of a hermetic compressor in the preferred embodiment 2 of the present invention.

Fig. 5 is a longitudinal sectional view of a conventional hermetic compressor.

[Description of the Reference Numerals and Signs]

[0052]

101 Hermetic container

102 Lubricating oil

103, 201 Motor element

105 Compressing element

106 Eccentric shaft

107	Main shaft
110	Shaft
111	Main bearing
121, 202	Stator
123, 203	Rotor core
124, 205	Permanent magnet
125, 206	Rotor
126, 210	Stator core
128	Conductor bar
131, 212	Bore

[Name of the Document] Abstract

[Abstract]

[Object] The object of the invention is to increase the amount of magnetic flux generated by the permanent magnet of the hermetic compressor in order to reduce the size, weight and cost, and to improve the efficiency.

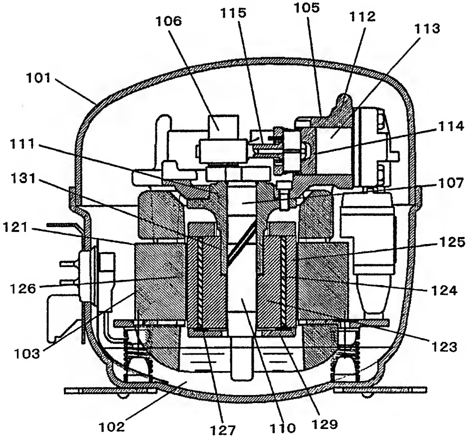
[Means to Solve the Problems] It comprises a bipolar permanent magnet type motor with permanent magnet 124 built in rotor core 123, wherein hollow bore 131 is formed in the end portion of compressing element 105 of rotor core 123, main bearing 111 extends internally of bore 131, and stack thickness of rotor core 123 is longer than the stack thickness of stator core 126, and thereby, the magnetic path of rotor core 123 can be formed wider, and as a result, the amount of magnetic flux generated in rotor core 123, that is conventionally insufficient due to bore 131, becomes increased, decreasing the loss and improving the efficiency. Further, the stack thickness of rotor core 123 that gives no direct influence to the height of hermetic container 101 is increased in length, thereby reducing the size, weight and cost.

[Selected Drawing] Fig. 1

[Name of the Document] Drawing

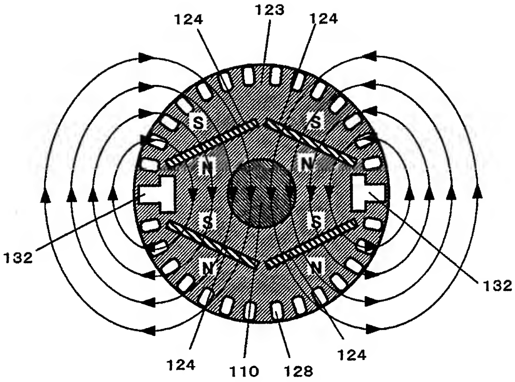
[Fig. 1]

101	Hermetic container
102	Lubricating oil
103	Motor element
105	Compressing element
106	Eccentric shaft
107	Main shaft
110	Shaft
111	Main shaft
121	Stator
123	Rotor core
124	Permanent magnet
125	Rotor
126	Stator core
131	Bore

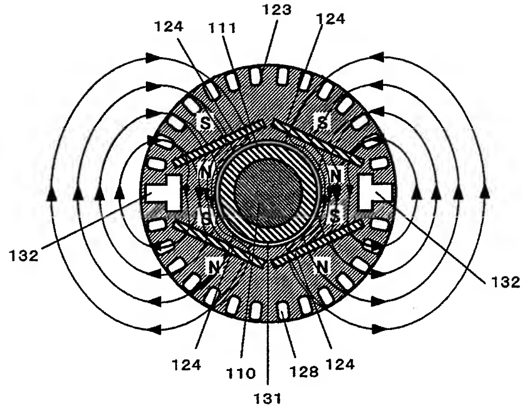


[Fig. 2]

128 Conductor bar

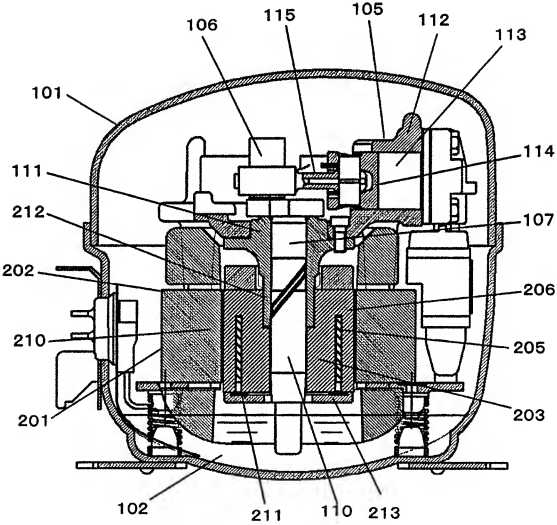


[Fig. 3]



[Fig. 4]

201	Motor element	205	Permanent magnet
202	Stator	206	Rotor
203	Rotor core	210	Stator core
		212	Bore



[Fig. 5]